

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Betty S. Jorgensen et al.

Docket No.: S-100,612

Serial No.:

Examiner:

Filed :

Art Unit:

For : CROSS-LINKED POLYBENZIMIDAZOLE
MEMBRANE FOR GAS SEPARATION

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 CFR 1.56, 1.97, AND 1.98

Sir:

The documents listed below, copies attached, are submitted in compliance with the duty of disclosure defined in 37 CFR 1.56.

1. Carl S. Marvel et al., "Polybenzimidazoles and Their Preparation," U. S. Patent Re. 26,065, reissued July 19, 1966.
2. Keith Clark Brinker et al., "Polybenzimidazoles," U. S. Patent 2,895,948, patented July 21, 1959.

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8(a))

I hereby certify that this correspondence is, on the date shown below, being:

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☒ deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to the:
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United States Patent and Trademark Office.

Date June 26, 2003

Samuel L. Borkowsky
Signature
Samuel L. Borkowsky
(type or print name of person certifying)

3. Abraham A. Boom, "Production of Improved Semipermeable Polybenzimidazole Membranes," U. S. Patent 3,699,038, patented October 17, 1972.
4. Willard C. Brinegar, "Reverse Osmosis Process Employing Polybenzimidazole Membranes," U. S. Patent 3,720,607, issued March 13, 1973.
5. Abraham A. Boom, "Production of Improved Semipermeable Polybenzimidazole Membranes," U. S. Patent 3,737,042, issued June 5, 1973.
6. Harvey Herbert Hoehn, "Heat Treatment of Membranes of Selected Polyimides Polyesters and Polyamides," U. S. Patent 3,822,202, patented July 2, 1974.
7. Howard J. Davis, "Chemical Modification of Polybenzimidazole Semipermeable," U. S. Patent 4,020,142, issued April 26, 1977.
8. Martin B. Sheratte, "Linear and Cross-Linked Polybenzimidazoles," U. S. Patent 4,154,919, issued May 15, 1979.
9. Donald G. J. Wang, "Process for the Production of Semipermeable Polybenzimidazole Membranes with Low Temperature Annealing," U. S. Patent 4,448,687, issued May 15, 1984.
10. Donald G. J. Wang, "Process for the Production of Semipermeable Polybenzimidazole Membranes and the Resultant Product," U. S. Patent 4,512,894, issued April 23, 1985.
11. Michael J. Sansone, "Crosslinking of Polybenzimidazole Polymer with Divinyl Sulfone," U. S. Patent 4,666,996, issued May 19, 1987.
12. R. Sidney Jones, Jr., "Polybenzimidazole Thin Film Composite Membranes," U. S. Patent 4,933,083, issued June 12, 1990.
13. J. S. Young, B. S. Jorgensen, B. F. Espinoza, M. W. Weimer, G. D. Jarvinen, Christopher J. Orme, Alan K. Wertsching, Eric S. Peterson, Vivek Khare, Alan R. Greenberg, and Scott Hopkins, "Polymeric-Metallic Composite Membranes for High-Temperature Applications, pp. 1-7, published November (2001).

14. Herward Vogel and C. S. Marvel, "Polybenzimidazoles, New Thermally Stable Polymers," *Journal of Polymer Science*, Vol. L, pp. 511-639, (1961).
15. Herward Vogel and C. S. Marvel, "Polybenzimidazoles II," *Journal of Polymer Science, Part A*, Vol. 1, pp. 1531-1541, (1963).
16. Lloyd M. Robeson, "Correlation of Separation Factor Versus Permeability for Polymeric Membranes," *Journal of Membranes Science*, Vol. 62, pp. 165-185, (1991).
17. M. E. Rezac and W. J. Koros, "Preparation of Polymer-Ceramic Composite Membranes with Thin Defect-Free Separating Layers," *Journal of Applied Polymer Science*, Vol. 46, pp. 1927-1938, (1992).
18. W. J. Koros and G. K. Fleming, "Membrane-Based Gas Separation," *Journal of Membrane Science*, Vol. 83, pp. 1-80, (1993).
19. Hidetoshi Kita, Tetsuya Inada, Kazuhiro Tanaka, and Ken-ichi Okamoto, "Effect of Photocrosslinking of Permeability and Permselectivity of Gases Through Benzophenone-Containing Polyimide," *Journal of Membrane Science*, Vol. 87, pp. 139-147, (1994).
20. May-Britt Hägg, "Membranes in Chemical Processing A Review of Applications and Novel Developments," *Separation and Purification Methods*, Vol. 27, pp. 51-168, (1998).
21. Claudia Staudt-Bickel and William J. Koros, "Improvement of CO₂/CH₄ Separation Characteristics of Polyimides by Chemical Crosslinking," *Journal of Membrane Science*, Vol. 155, pp. 145-154, (1999).
22. Y. Liu, C. Pan, M. Ding, and J. Xu, "Effect of Crosslinking Distribution on Gas Permeability and Permselectivity of Crosslinked Polyimides," *European Polymer Journal*, Vol. 35, pp. 1739-1741, (1999).
23. William J. Koros and Rajiv Mahajan, "Pushing the Limits of Possibilities for Large Scale Gas Separation: Which Strategies?," *Journal of Membrane Science*, vol. 175, pp. 181-196, (2000).

24. Rajiv Mahajan and William Koros, "Mixed Matrix Membrane Materials with Glassy Polymers, Part 2," Polymer Engineering and Science, Vol. 42, No. 7, pp.1432-1441, July 2002.

25. Robert C. Dye et al., "Meniscus Membranes for Separations," U. S. Application S/N 09/826,484, filed april 4, 2001.

This Information Disclosure Statement is not to be construed as a representation that a search has been made or that additional matter material to the examination of this application does not exist. Applicant does not believe that any of these citations constitutes prior art under 35 U.S.C. 102.

It is requested that the above citations be made of record in the prosecution of this application.

Respectfully submitted,

Date: June 26, 2003

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		Filing Date	Group

37 CFR 1.98(b)

U.S. PATENTS DOCUMENTS

EXAMINER INITIAL	PATENT NUMBER								ISSUE DATE	PATENTEE	CLASS	SUB CLASS	FILING DATE
		R	E	2	6	0	6	5	07/19/1966	Carl S. Marvel et al.	260	47	
		2	8	9	5	9	4	8	07/21/1959	Keith Clark Brinker et al.	260	78.4	10/28/1955
		3	6	9	9	0	3	8	10/17/1972	Abraham A. Boom	210	23	04/22/1970
		3	7	2	0	6	0	7	03/13/1973	Willard C. Brinegar	210	23	04/15/1970
		3	7	3	7	0	4	2	06/05/1973	Abraham A. Boom	210	321	01/20/1972
		3	8	2	2	2	0	2	07/02/1974	Harvey Herbert Hoehn	210	23	11/02/1972
		4	0	2	0	1	4	2	04/26/1977	Howard J. Davis et al.	264	347	04/26/1977
		4	1	5	4	9	1	9	05/15/1979	Martin B. Sheratte	528	186	08/31/1986

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL	PATENT NUMBER								ISSUE DATE	COUNTRY	CLASS	SUB CLASS	Translation YES NO	

OTHER DOCUMENTS (Including Author, Title, Date, Place of Publication)

	J. S. Young, B. S. Jorgensen, B. F. Espinoza, M. W. Weimer, G. D. Jarvinen, Christopher J. Orme, Alan K. Wertsching, Eric S. Peterson, Vivek Khare, Alan R. Greenberg, and Scott Hopkins, "Polymeric-Metallic Composite Membranes for High-Temperature Applications, pp. 1-7, published November (2001)
✓	Herward Vogel and C. S. Marvel, "Polybenzimidazoles, New Thermally Stable Polymers," Journal of Polymer Science, Vol. L, pp. 511-639, (1961)
✓	Herward Vogel and C. S. Marvel, "Polybenzimidazoles II," Journal of Polymer Science, Part A, Vol. 1, pp. 1531-1541, (1963)
✓	Robert C. Dye et al., "Meniscus Membranes for Separations," U. S. Application S/N 09/826,484, filed april 4, 2001

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OTHER DOCUMENTS (Including Author, Title, Date, Place of Publication)														
			4	4	4	8	6	8	7	05/15/1984	Donald G. J. Wang	210	500	12/17/1982
			4	9	3	3	0	8	3	06/12/1990	R. Sidney ones, Jr.	210	490	04/15/1985
✓	Lloyd M. Robeson, "Correlation of Separation Factor Versus Permeability for Polymeric Membranes," Journal of Membranes Science, Vol. 62, pp. 165-185, (1991)													
✓	M. E. Rezac and W. J. Koros, "Preparation of Polymer-Ceramic Composite Membranes with Thin Defect-Free Separating Layers," Journal of Applied Polymer Science, Vol. 46, pp. 1927-1938, (1992)													
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